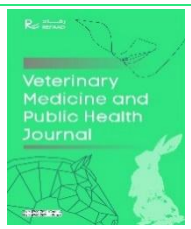
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Prevalence of Camel Hydatidosis: Its Association, Risk Factors and Financial Losses at Jigjiga Municipal Abattoir, Somali Region, Eastern Ethiopia

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Abstract:

Objectives: This paper aims to determine the prevalence of camel hydatidosis among dromedary camels slaughtered at Jigjiga Municipal Abattoir, assess associated risk factors, identify the distribution of hydatid cysts in affected organs, and estimate direct economic losses resulting from organ condemnation.

Methods: Camel hydatidosis caused by the larval stage of Echinococcus garanulosus is an important zoonotic parasitic disease with significant veterinary, public health, and economic losses. Therefore, a cross-sectional study was conducted from Sep 2024 to June 2026 at Jigjiga Municipal Abattoir, Somali Region, Eastern Ethiopia. A total of 384 dromedary camels originating from different zones of the Somali Region, such as Erer, Nogob, Libaan, and Fafan zones, were selected using a systematic random sampling technique. Ante-mortem examination was conducted to record the animals' origin, age, sex, and BCS, followed by detailed post-mortem examination of visceral organs using visual inspection, palpation, and systematic incision. Selected non-calcified cysts were examined for protoscoleces to assess cyst viability. Data were entered into Microsoft Excel and analyzed using SPSS version 27. The Chi-square test was used to evaluate associations between hydatidosis and potential risk factors.

Results: 384 camels were examined; 147 were positive for hydatidosis; overall prevalence was 38.3%, and prevalence varied significantly by origin, sex, and age. The highest prevalence was found among camels originating from the Erer zone 50%, followed by the Nogob zone 43% and Fafan zone, while the lowest prevalence was found in the Libaan zone 17.3% (P>0.05). In she-camels, a higher prevalence of 64.3% was found compared to male camels 18.5% (P < 0.05). Prevalence also increased with age, from 4.9% in young camels to 51,5% in adults and 56.3% in old camels. Although hydatidosis was more frequent among camels with poor body condition, the association was not statistically significant P(>0.05).

Conclusion: The current study showed that camel hydatidosis is common (38.3%) among camels slaughtered in Jigjiga Municipal Abattoir, indicating its importance for both animals and public health in the study area. The analysis showed that origin, sex, and age of animals were statistically significant risk factors (P<0.050, whereas body condition score was not statistically significantly associated with the occurrence of the disease. The condemnation of infected organs resulted in substantial direct financial losses, estimated at 4,569,763.5 annually, highlighting the economic impact of the disease on the livestock and abattoir industry. This finding demonstrates that camel hydatidosis is a major veterinary, public health, and economic concern in the study area. Overall, the study confirms that hydatidosis is highly prevalent among camels slaughtered at Jigjiga Municipal Abattoir and causes substantial organ condemnation and economic losses.

Keywords: *Jigjiga abattoir; Associated Risk; camel; Echinococcus granulosus; Economic loss; prevalence; organ Condemnation.*

1 Introduction

Echinococcus granulosus, or hydatidosis (EC), is a significant parasitic zoonotic illness caused by the metacestode of the canine tapeworm Echinococcus granulosus (Anvari *et al*. 2021). The adult stages of the parasite occur primarily in the intestines of dogs and other canids, which act as definitive hosts. Infection occurs when intermediate or accidental hosts ingest parasite eggs shed in the feces of infected dogs. The larvae then develop into hydatid cysts in different organs, particularly the liver, lungs, heart, and brain, which may result in death (Abo-aziza *et al*. 2019). Hydatidosis causes considerable veterinary, public health, and economic problems due to its impact on animal production, organ condemnation, and the costs associated with the treatment of human cases (Branch *et al*. 2021). Hydatidosis occurs in many parts of the world and is considered an important zoonotic disease, particularly in developing countries, including Ethiopia. The disease is commonly maintained through a cycle involving dogs as definitive hosts and livestock as intermediate hosts. Humans can become infected accidentally through exposure to parasite eggs in contaminated environments. Continued interaction among dogs, livestock, and humans contributes to the disease's persistence in endemic areas (Hayer, Kebede, and Warsame 2018). Camels play an essential role in producing meat and milk, providing draught power, and determining the wealth and social status of pastoralists (Gizachew, Kibru, and Asrade 2013a). Camel meat is also an important component of the diet and a source of income for pastoral communities (Salih *et al*. 2011). Moreover, the camel's broad home range in pastoral areas, poor veterinary services, and improper disposal of offal and carcasses are known to expose the camel to various pathogens, including parasite eggs. Specifically, the large number of dogs kept by the pastoralists and the wild carnivores freely roaming in the area can potentially contaminate the communal watering points and the pasture with eggs of Echinococcus granulosus (Abebe, Asrade, and Mekibib 2021). Although nearly two- thirds of the world's livestock are found in developing countries, they only produce a fifth of the world's milk and less than a third of its meat (Hayer, Kebede, and Warsame 2018). Echinococcus is one of the most important zoonotic parasitic diseases occurring worldwide and causes significant economic losses and health problems in several countries (Nejad *et al*. 2012).

There have been reports of both alveolar and cystic echinococcus from numerous locations. On the other hand, reports of cystic echinococcus have come from every country in the Middle East and North Africa. In endemic areas, the infection has medical, veterinary, and economic importance because of its public health significance to humans, morbidity in animals, and condemnation of organs and meat inspection in the abattoir. The parasite is found all over the world, but it is especially common in rural areas where it is spread in a cycle between the dog, which is the definitive host, and humans, sheep, camel, and other ruminants, which serve as intermediate hosts, causing serious economic and health issues. These animals become infected by eating eggs from a contaminated environment, usually canine feces. After ingestion, the parasite develops into hydatid cysts, mainly in the liver and lungs, although other organs may also be affected (Fakhri *et al*. 2024). Hydatid cysts are caused by Echinococcus parasites, which account for an estimated 2-3 million human cases worldwide, representing over 95% of cases. Hydatid cysts are found in almost every part of the body; however, they are typically found in the liver, lung, mediastinum, peritoneum, and other tissues. In animals, hydatid cysts usually remain an asymptomatic disease, producing no clinical symptoms, and their course is slow (Kamal *et al*. 1966). According to the diagnosis, an Echinococcus cyst in human cases was established based on clinical findings, imaging results, and serology. The clinical signs of this condition include cyst rupture, subsequent bacterial infection, allergic responses, or anaphylaxis. Although ultrasound is a vital diagnostic, staging, and follow-up tool for abdominal cyst echinococci, its sensitivity for identifying small cysts is low. Therefore, the current study aims to determine the prevalence of camel hydatidosis, its associated risk factors, estimate direct financial loss, and identify the distribution of hydatid cysts in affected organs.

2 Material and Methods

2.1 Descriptive Study Area

The study was conducted at the Jigjiga Municipal Abattoir in Jigjiga city, Somali Region, Eastern Ethiopia. Jigjiga is situated approximately 630 KM east of Addis Ababa at an altitude ranging from 1,660 to 1,710 meters above sea level. The geographical coordinates of the city are approximately 9°20′ N latitude and 45°56′ E longitude. The area has a mean annual and

temparutre 22°C and an annual rainfall of approximately 543 mm. (CSA 2019). The abattoir has a separate compartment to slaughter animals for Christian and Muslim residents. On average, 25 cattle for Christians and 36 for Muslims were slaughtered per day, and an average of 25-35 camels were slaughtered per day. (Somali regional State pastoral development bureau, 2015).

2.2 Study Population

The study population consisted of all dromedary camels (Camelus dromedarius) present at Jigjiga Municipal Abattoir during the study period. The camels originated mainly from different areas of the Somali region, including Erer, Nogob, Libaan, and Fafan zones. During ante-mortem examination, relevant information on each selected camel, including its origin, sex, age, and body condition score, was recorded. A total of 384 selected camels were subsequently subjected to detailed post-mortem examination to detect hydatid cysts. The lungs, liver, heart, kidneys, and spleen were carefully inspected through visual examination, palpation, and systematic incision for the presence of hydatid cysts.

2.3 Study Design

A cross-sectional study was conducted between Sep 2024 and June 2026 at the Jigjiga Municipal abattoir to determine the prevalence of hydatidosis in slaughtered dromedary camels, identify associated risk factors, and estimate the direct financial losses. The abattoir is visited five days per week out of seven slaughter days. On average, 25-30 camels were slaughtered daily, and 20 camels were sampled during each visit. The systematic random sampling technique was used to select camels. The first camel was selected randomly from the slaughter line, and subsequently, every camel was selected at regular intervals until the desired sample size was obtained.

2.4 Sample Size Determination and Sampling Method

The required sample size was determined using the standard formula for estimating population proportion as described by Thrusfield (Michael Thrusfield 2007).

$$n = Z^2P(1 - P) / d^2$$

Where:
n = required sample size;
Z = value of the standard normal distribution corresponding to a 95% confidence level (1.96);
P = expected prevalence;
d = desired absolute precision.

Because an expected prevalence of 50% was used in the absence of sufficiently recent prevalence information for the target population, with a desired precision of 5%, the sample size was calculated as:

$$n= (1.96)^2 \times 0.50 \times (1 - 0.50) / (0.05)^2 \; n = 384;$$

Therefore, a total of 384 camels were included in the study

2.5 Study Methodology

2.5.1 Ante-Mortem Examination

Ante-mortem (AM) examination of camels was performed in the lairage. The origin of camels was identified during ante-mortem examination using information obtained from animal traders, owners, and transporters, together with reviewing abattoir registration records before slaughter, and each camel brought to the abattoir was traced to its reported area of origin, such as

Pre-slaughter examinations of camels were performed in the lairage. The origin of camels was identified during ante-mortem examination using information obtained from animal traders, owners, and transporters, together with reviewing abattoir registration records before slaughter, and each camel brought to the abattoir was traced to its reported area of origin, such as Erer, Nogob, Libaan, and Fafan zones

2.5.2 Post-Mortem Examination

Post-mortem (PM) examination was performed based on the guidelines set in the annual meat inspection for developing countries. Consequently, vision, palpation, and methodical incision were used to check for any abnormal lesions in the lung, heart, kidneys, liver, and spleen.(Kassaye, Abdi, & Kefyalew, 2019).

2.6 Cyst Viability

For fertility and viability testing, non-calcified cysts were randomly selected, removed from different organs, and transported to the Jigjiga Regional Veterinary Laboratory using an ice box. We used a sterile scalpel blade to cut the cyst on a clean Petri dish, then transferred the fluid portion to another Petri dish. The supernatant was decanted, and the sediment was finally examined for protoscoleces, which are seen as white dots under 40X magnification(Gizachew, Kibru, and Asrade, 2013).

2.7 Data Management and Analysis

Data collected during the antemortem and postmortem examinations were entered into a

Microsoft Excel spreadsheet and analyzed using SPSS version 27. The association between camel hydatidosis and potential risk factors, including origin, age, sex, and body condition score, was assessed using the chi-square test. Odds ratios with 95% confidence intervals were calculated to measure the strength of association between the selected risk factors and the occurrence of hydatidosis. 95% confidence intervals and (P<0.05) were considered statistically significant.

3 Result

3.1 Prevalence of camel hydatidosis

384 camels were tested for hydatidosis during the study period; 147 (38.3%) became positive for hydatidosis. The Erer zone had the highest prevalence (50%, followed by Nogob 43% and Fafen 43.02%, while the lowest prevalence was found in Libaan (17.3%. Differences in management systems, environmental conditions, dog populations, and disease control measures in the areas may be the cause of variation. The results showed a marked variation in hydatidosis between male and female camels; she camels found a high prevalence (64.3%) compared to males (18.1%). There is a statistically significant distinction between sex and hydatidosis infection (P < 0.05). These differences between sexes may be because she-camels are usually kept longer for breeding and production, increasing their exposure to infection. The prevalence of camel hydatidosis was assessed based on BCS, and the highest prevalence was found in camels with poor body condition (72.7%), followed by medium (41.3%), and the lowest prevalence was found in those with good body condition (26.9%). However, there is no statistically significant association between BCS and hydatidosis (P>0.05).

Table 1: Prevalence of camel hydatidosis by origin of animals

Variables	No. of examined animals	No. of positive animals	Prevalence	OR 95% CL	P-value
Fafan zone	86	37	43.02%	Reference	<.000
Erer zone	100	50	50%	4.2(1.32-13.65)	<.015
Nogob zone	100	43	43%	1.922 (95% 0.56–6.55)	0.297
Libaan zone	98	17	17.3%	21.573 (95% 5.77–80.64)	<.000
Total	**384**				

Table 2: Prevalence of camel hydatidosis based on sex of camels

Variables	Categories	No. of examined animals	No. of positive animals	Prevalence	OR 95% CI	P-value
Sex	F	168	108	64.3%	Reference	<.000
	M	216	39	18.05%	6.05 (3.00–12.22)	<.000
Total		**384**				

Table 3: Prevalence of camel hydatidosis based on age of camels

Variables	Categories	No. of examined animals	No. of positive animals	Prevalence	OR 95% CI	P-value
Age	Old	126	71	56.3%	Reference	<.000
	Young	122	6	4.9%	264.8 (64.72–1083.40)	<.000
	Adult	136	70	51.5%	2.670 (1.25–5.72)	<.012
Total		**384**				

Table 4: Prevalence of camel hydatidosis based on BCS of camels

Variables	Categories	No. examined animals	No. of positive animals	Prevalence	OR 95% CI	P-value
BCS	Good	67	22	32.8%	Reference	>.469
	Poor	14	11	78.6%	1.022 (0.15–7.08	>.982
	Medium	303	114	37.6%	1.798(0.64–5.06)	>.267
Total		**384**				

3.2 Organ distribution level of the cyst

The total number of organs examined was 506, of which 178 organs were found to be affected by hydatid cysts, resulting in an overall prevalence of 35.18%, with the highest relative percentage recorded in the lung (50.3%), followed by the liver (47.01%), kidneys (23.5%), heart (5.88%), and spleen (3.8%) (Table 5). This indicates that the lungs are the primary site of cyst localization in the studied animals.

Table 5: Distribution of organs affected in camels slaughtered at Jigjiga Municipal Abattoir

Organs	Total No of examined organs.	Total No of affected Organs	Prevalence rate	Organs	Total No of examined organs
Lung	183	92	50.3%	Lung	183
Liver	151	71	47.01%	Liver	151
Heart	85	5	5.88%	Heart	85
Kidneys	34	8	23.5	Kidneys	34
Spleen	53	2	3.8%	Spleen	53
Total	**506**	**178**			

3.3 Financial losses

The annual direct financial loss from hydatid cyst infection has been estimated using the following formula:

Annual financial loss = annual slaughter rate*rejection rate*average organ price.

Annual camel slaughter rate= average number slaughtered per day*365 days

Therefore, if the abattoir slaughters approximately 30 camels per day 30*365= 10,950 camels per year.

The analysis showed that liver condemnation accounted for the largest economic loss (ETB 4,051,500) due to its high market value, followed by lungs (ETB 455,301), kidneys (ETB 34,492.5), heart (ETB 22,776), and spleen (ETB 5,694). Although the prevalence of infection in the heart, kidneys, and spleen was relatively low, their condemnation also contributed to the overall financial loss. The total annual financial loss was calculated to be 4,569,763.5 ETB (Table 6).

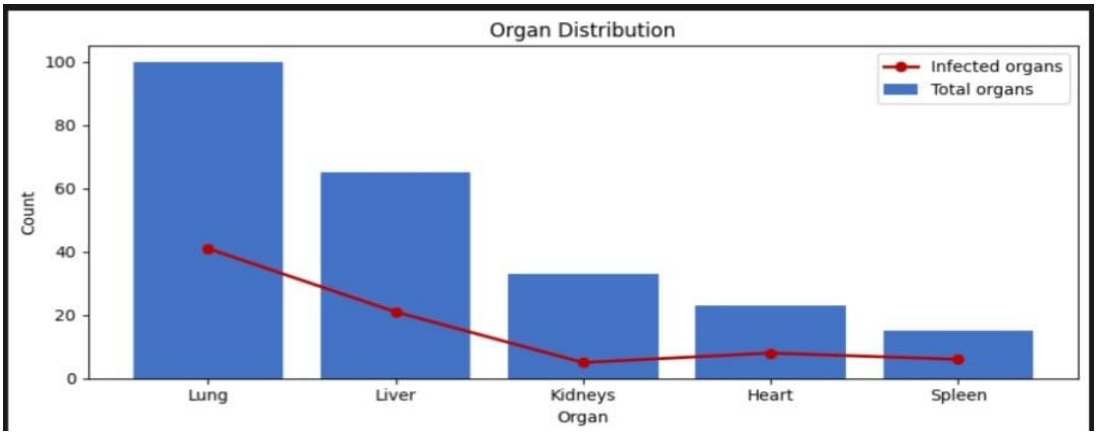


Figure 1: Total No. of affected organs during the study period at Jigjiga Municipal Abattoir

Table 6: Proportion of condemned organs and estimating direct financial losses

Condemned organs	Total No of organs condemned	Rejection rate %	Annual slaughter rate of camels per year in Jigjiga abattoir	Average price per organ in ETB	Financial loss per organ in ETB
Lung	92	23.10%	10,950	180	455,301
Liver	71	18.5%		2,000	4,051,500
Heart	5	1.3%		160	22,776
Kidneys	8	2.1%		150	34,492.5
Spleen	2	0.52%		100	5,694
Total	**178**				**4,569,763.5 ETB**

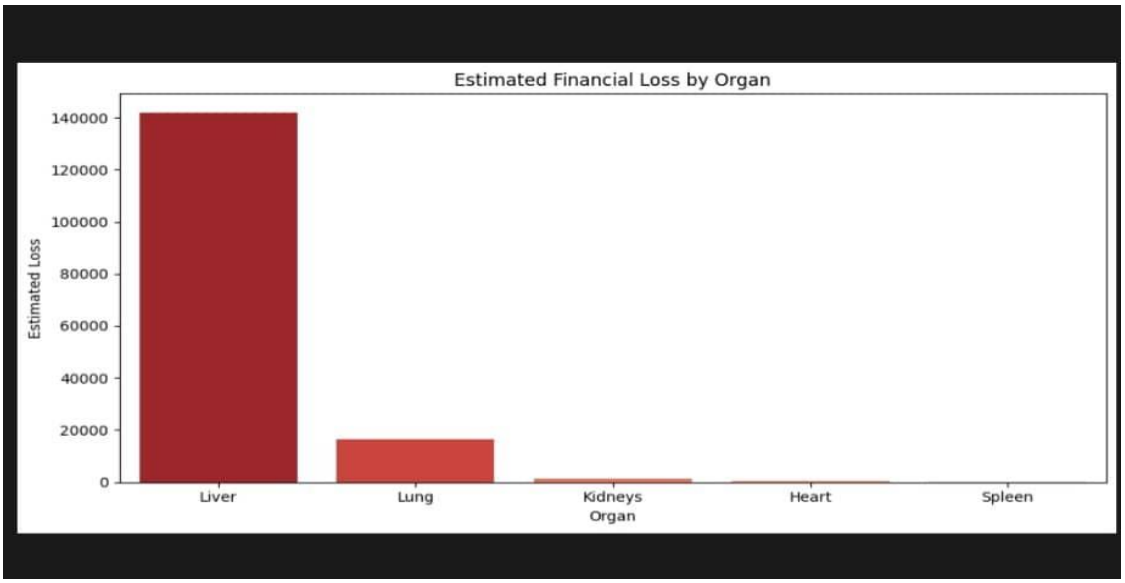


Figure 2: Estimating the annual financial loss of camels slaughtered at the Jigjiga Municipal Abattoir

4 Discussions

Hydatidosis is one of the most widely distributed zoonotic diseases in developed and developing countries in all inhabited continents, in temperate, subtropical, tropical, subarctic, and arctic countries. The present study found that 38.3% of slaughtered dromedary camels across different zones of the Somali region were infected with hydatid cysts. The prevalence found in the current study (38.3%) was comparable to previous findings reported at the Addis Ababa municipal abattoir (38.22%) (Abebe, Asrade, and Mekibib 2021)(30.82%) (Moghaddas *et al*. 2014) reported in Iran (34.20%) (Gebremichael *et al*. 2013) reported in Ayssaita, Northern Ethiopia. The relatively similar prevalence estimates may be attributed to similarities in camel production system exposure to contaminated environments, dog-livestock interaction, slaughter practices, and use of abattoirs based on post-mortem examination for detecting hydatid cysts. The present study is higher than the previous studies reported in the previous study conducted at the Jigjiga municipal abattoir (23%) (Debela, Abdulahi, and Megersa 2015)(18.79%) (Kassaye, Abdi, and Kefyalew 2019) reported in the Jigjiga municipal abattoir, eastern Ethiopia (14.64%) (Mirzaei and Rezaei 2016) reported in Iran, abattoir (20.73%),(Fathi *et al*. 2011) reported in Kerman, Iran, (23.75%) (Anvari *et al*. 2021) reported across the world (28.67%), (Hayer, Kebede, and Warsame 2018) reported in the Dire Dawa Municipal abattoir (4.292%), (Zahmoul *et al*. 2026) reported in Zabratha city, Libya (3.7%) (Basiony *et al*. 2021) reported in Sharkia abattoir, Egypt. The higher prevalence found in the present study compared with some previous studies may be attributed to differences in study areas, camel management systems, animal age composition, dog–livestock interactions, slaughter and offal-disposal practices, diagnostic methods, and sampling periods.

The predominantly pastoral production system in the Somali Region, together with close interaction between camels and dogs, may facilitate the maintenance and transmission of *Echinococcus granulosus*. In addition, differences in the circulation of Echinococcus granusus strains between geographical areas may contribute to the observed variation. The current study is slightly lower than the comparison (65.47%) (Gizachew, Kibru, and Asrade 2013) reported in Addis (61.6%) (Boru *et a*l. 2013) reported in Akaki abattoir, Ethiopia (48%) (Basiony *et al*. 2021a) reported in Libya. The lower prevalence found in the current study may be due to the unique camel husbandry and feeding management of camels, which depend on raising them on a farm under a restricted feeding system for high-quality meat production, milk, and breeding, as well as the less frequent interaction between camels and stray dogs. The highest prevalence was found in camels originating from the Erer zone (50%, followed by the Nogob zone and Fafen, while the lowest prevalence was observed in the Libaan zone (17%. This difference could be explained by environmental and management-related factors, such as the level of interaction between livestock and dogs, the availability of veterinary services, and proper disposal of infected offal. Areas with poor control of stray dogs and improper slaughter practices are more likely to have higher transmission rates of Echinococcus garnulosus. Sex of animals was also

found to be a highly significant risk factor (P<0.05), with the she-camels (64.3%) showing a markedly higher prevalence compared to male camels (18.1%). These findings are consistent with several previous studies (Kassaye, Abdi, and Kefyalew 2019) conducted at Jigjiga Municipal abattoir, while the current study is lower than the previous study (Reghaissia, Dahmane, and Samari 2023) conducted at Tindouf abattoir, southern Algeria (Union and Africaine 2012). Age was another significant factor influencing the occurrence of hydatidosis.

The prevalence increased from 4.9% in young camels to 51.5% in adult camels and 56.3% in old camels, with a statistically significant association (P<0.05). This trend is biologically plausible, as hydatidosis is a chronic disease with a long incubation period, and the likelihood of infection increases with cumulative exposure over time. Older camels have had more opportunities to ingest infective eggs from contaminated environments, leading to higher infection rates. In contrast, although the prevalence of hydatidosis appeared high in camels with poor body condition (72.7%) compared to the medium (41.3%) and good body condition (29.9%), the association was not statistically significant (P>0.05). This showed that the body condition score may not be a direct risk factor for infection. Instead, poor body condition could be a consequence of chronic parasitic disease, including hydatidosis, or other concurrent disease. Additionally, the small number of animals in the poor body condition category may have limited the statistical power to detect a significant association. The overall prevalence of affected organs was 35.18%, and the highest prevalence was recorded in the lungs 23.10% and in the liver (18.5%). This finding is comparable with previous reports from Ethiopia, including (23.8) by (Abdi and Mohamed 2024) at Jigjiga Municipal abattoir, and reported by (28.66%) (Gizachew, Kibru, and Asrade 2013) at Addis Ababa abattoir. However, the current value is higher than that reported in the previous study (6.06%) (Mirzaei and Rezaei 2016) reported in Tabriz, Iran. The present study is lower than several other studies about organ condemnation, including (51.28) by (Kassaye, Abdi, and Kefyalew 2019) at Jigjiga Municipal abattoir, (56.0) by (Debela, Abdulahi, and Megersa 2015) at Jigjiga Municipal abattoir, (40.39%) by (Boru *et al*. 2013) at Akaki Abattoir (67.3%) by (Salih *et al*. 2011) at the Kereyu and Harar areas of Ethiopia (45.06%) by (Hayer, Kebede, and Warsame 2018) at the Dire Dawa Municipal abattoir, 87.61% reported in Addis Ababa, Akaki, Kality municipal abattoir, Ethiopia (63.6%) (Basiony *et al*. 2021) reported in Egypt. The variation in organ condemnation prevalence observed between the current study and the previous study may be attributed to several factors. These include differences in geographical location, climate, environmental conditions, animal husbandry and management practices, age and origin of slaughtered animals, and the prevalence of parasitic and infectious diseases in the study areas. Variation in sample size, study period, and slaughterhouse inspection procedures may also contribute to the observed differences.

5 Conclusion and Recommendations

The current study showed that camel hydatidosis is common (38.3%) among camels slaughtered in Jigjiga Municipal Abattoir, indicating its importance for both animals and public health in the study area. The analysis showed that origin, sex, and age of animals were statistically significant risk factors, whereas body condition score was not statistically significantly associated with the occurrence of the disease. Higher infection rates in older and female camels suggest that prolonged exposure to the parasite plays a major role in disease transmission. The organ distribution analysis showed an overall prevalence rate of 35.18%, and the lungs and liver were the most commonly affected organs, confirming their importance as the primary sites of hydatid cyst localization in camels. The condemnation of infected organs resulted in substantial direct financial losses, estimated at **4,569,763.5** annually, highlighting the economic impact of the disease on the livestock and abattoir industry.

Based on the current findings of this study, the following recommendations are proposed to Jigjiga Municipal Abattoir

- Somali Regional veterinary authorities should strengthen routine ante-mortem and post-mortem meat inspection at Jigjiga Municipal Abattoir and other slaughter facilities in the region.
- Proper disposal of infected organs at Jigjiga Municipal Abattoir should be strictly enforced to prevent access by dogs.
- Regular sanitation and hygiene practices at Jigjiga Municipal Abattoir should be improved, including cleaning of slaughter areas and proper waste management systems.
- Training and capacity building of Jigjiga Municipal Abattoir meat inspectors and workers should be strengthened to improve detection, reporting, and safe handling of hydatid cysts.

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The authors declare that there is no conflict of interest.

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List of Appendixes

Appendix 1: Photos taken during inspection of Organs



Appendix 2: Photos taken during the examination of the cyst

